

Node Classification and Geographical Analysis of the Lightning Network

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Today's talk

- Lightning Network: Short introduction
- Preliminaries: Some necessities for further understanding
- Data set
- Node Classification: Labeling nodes in the data set
- Geographical Analysis: Client distribution and node connections
- Summary

Lightning Network Overview

- Off-chain network
- Created to counteract the scalability problem in blockchain systems i.e. Bitcoin
 - Due to
 - Consensus protocol
 - Missing trusted third party authority
- Allows making direct payments between users without involving the blockchain

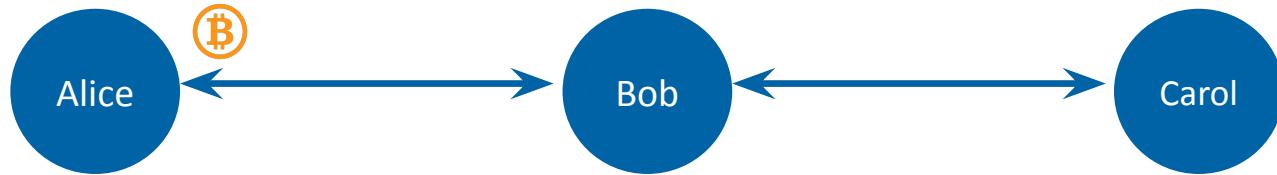


Preliminaries

- Currently three main clients available
 - LND (Go)
 - C-Lightning (C++)
 - Eclair (Scala)
- Two important transactions that are propagated onto the blockchain
 - Funding transaction
 - Closing transaction

Preliminaries

- Payment routing through multiple hops is also possible



- Gossip messages
 - node_announcement – node_id
 - channel_announcement
 - channel_update – fee_base_msat

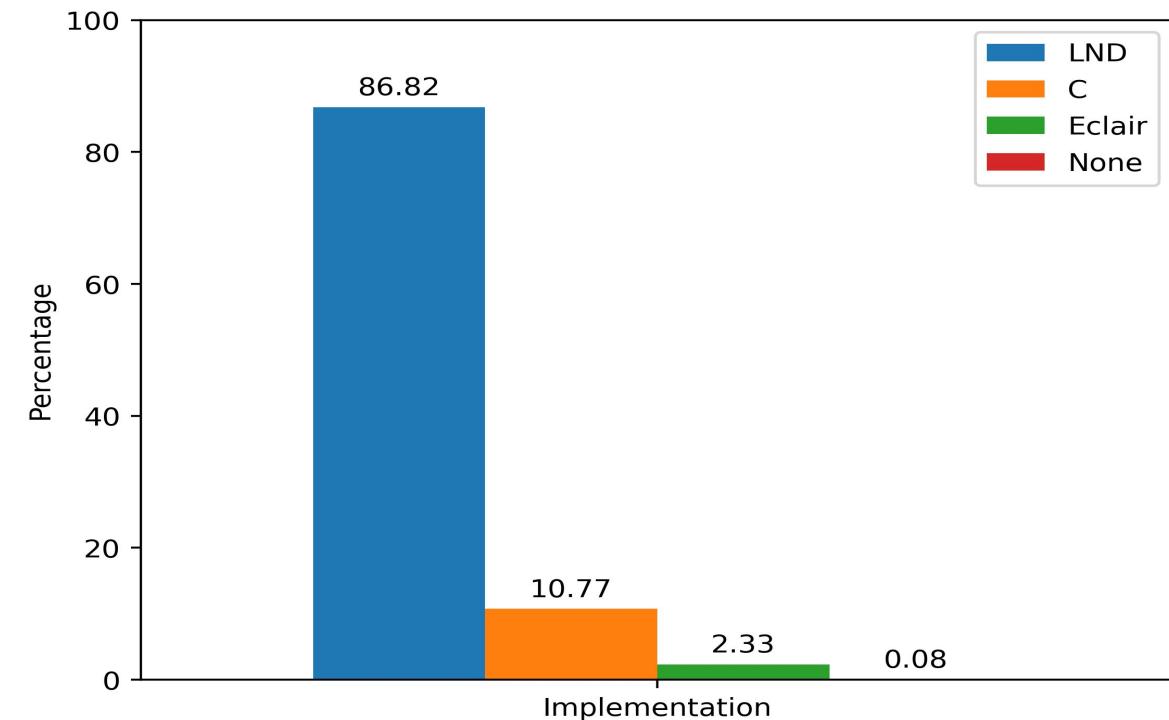
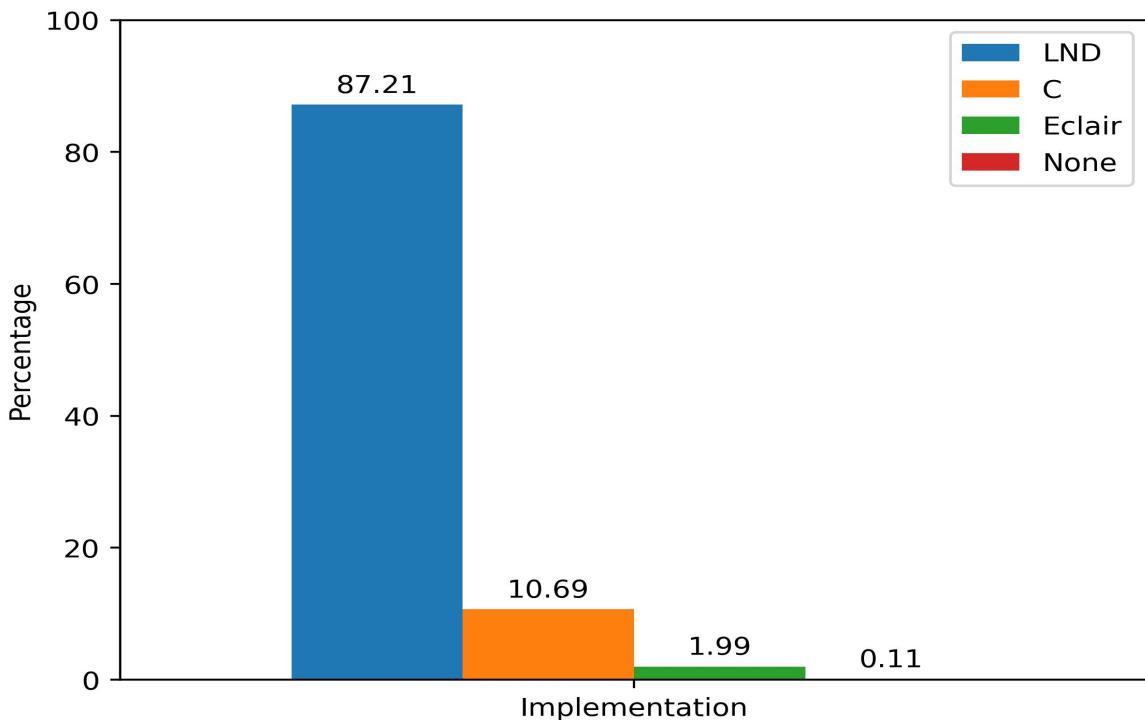
Data set

- Recorded from March 2018 to January 2020
 - 400.000 node_announcement messages
 - 1 million channel_announcement messages
 - 6.4 million channel_update messages
- Goals
 - Classify nodes based on the default values in these gossip messages
 - Perform a geographical analysis with the data set and labeled data
- Publicly available at <https://github.com/lvresearch/topology>

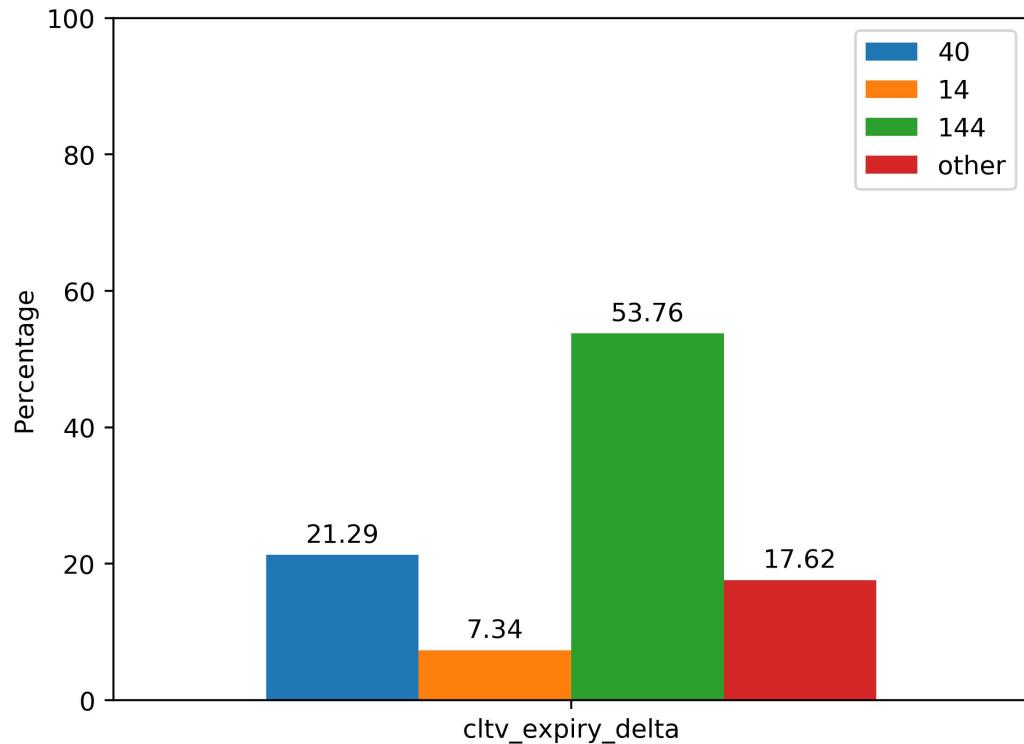
Node Classification

- Attackers may want to deduce private default values by inferring the client of a given node
- Nodes can flood the network with messages
 - Up to 1000 messages a day
- In two years a many nodes & channels are created and many updates happen
 - How to process this amount of data?
 - Most frequent values
 - Most frequent classification

Node Classification – Labeling



Node Classification – Default values



- Observance
 - Most nodes use default values
 - LND: 40 (144 old)
 - C-Lightning: 14
 - Eclair: 144
- Possible classification approach without default values
 - Measure performance in network

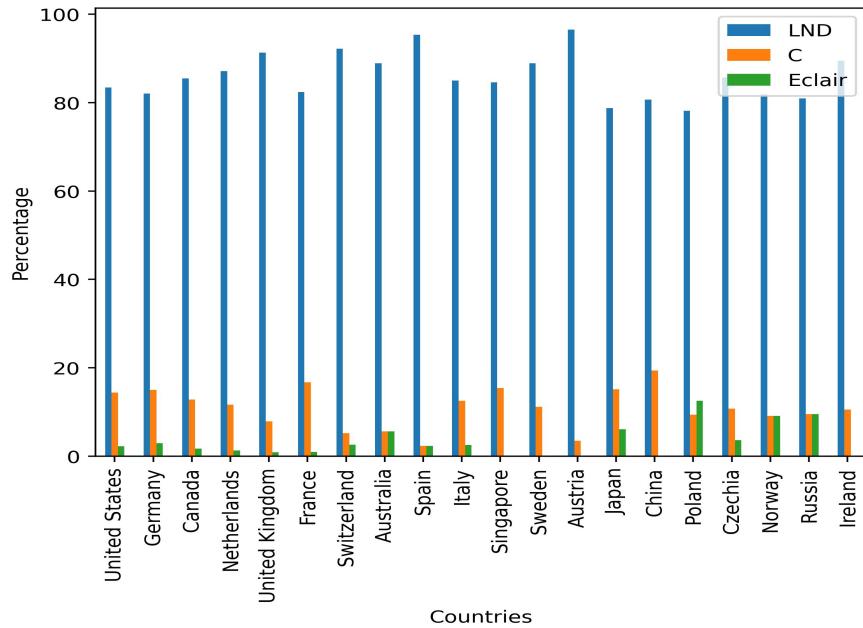
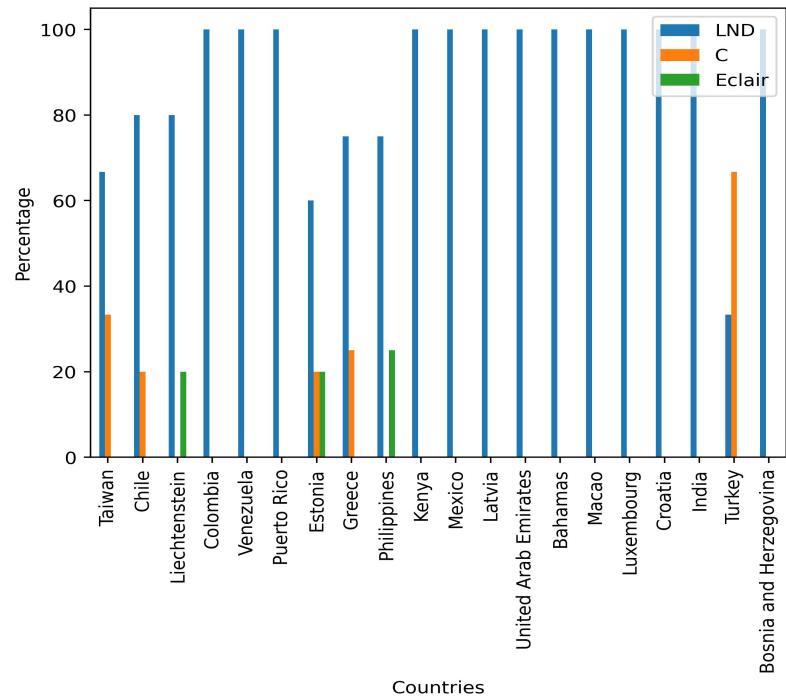
Node Classification – Implementation Distribution

- First version of C-Lightning in 2016
 - Offered only source code
 - Had to be compiled on Linux or UNIX based systems
- First LND version in 2017
 - Offered precompiled version for various OS including Windows
 - Easy installation process

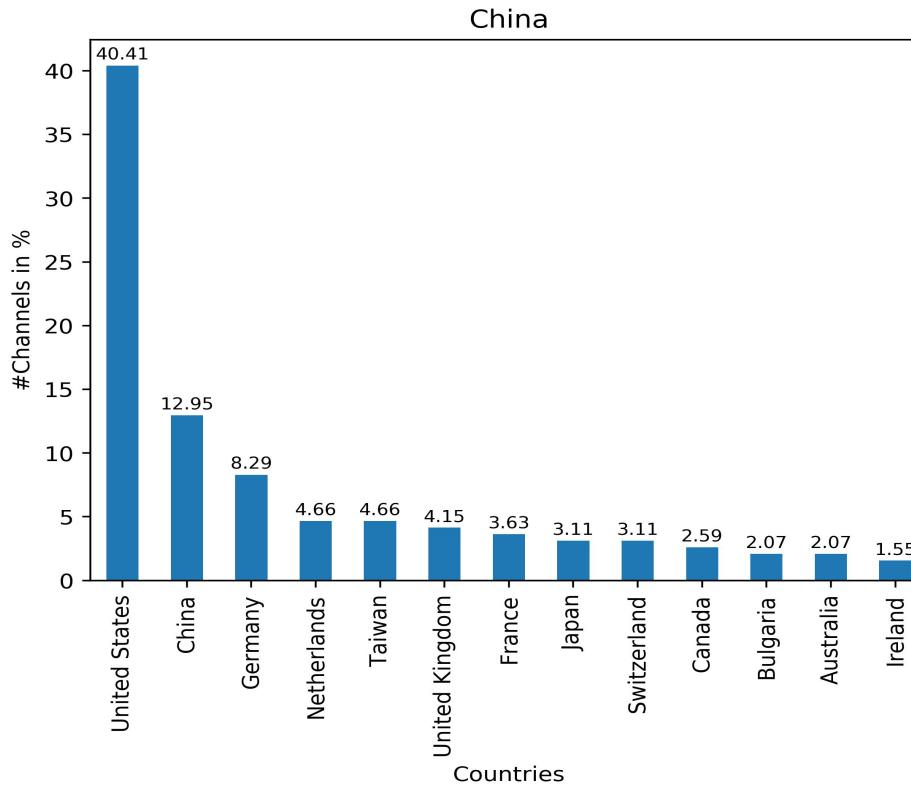
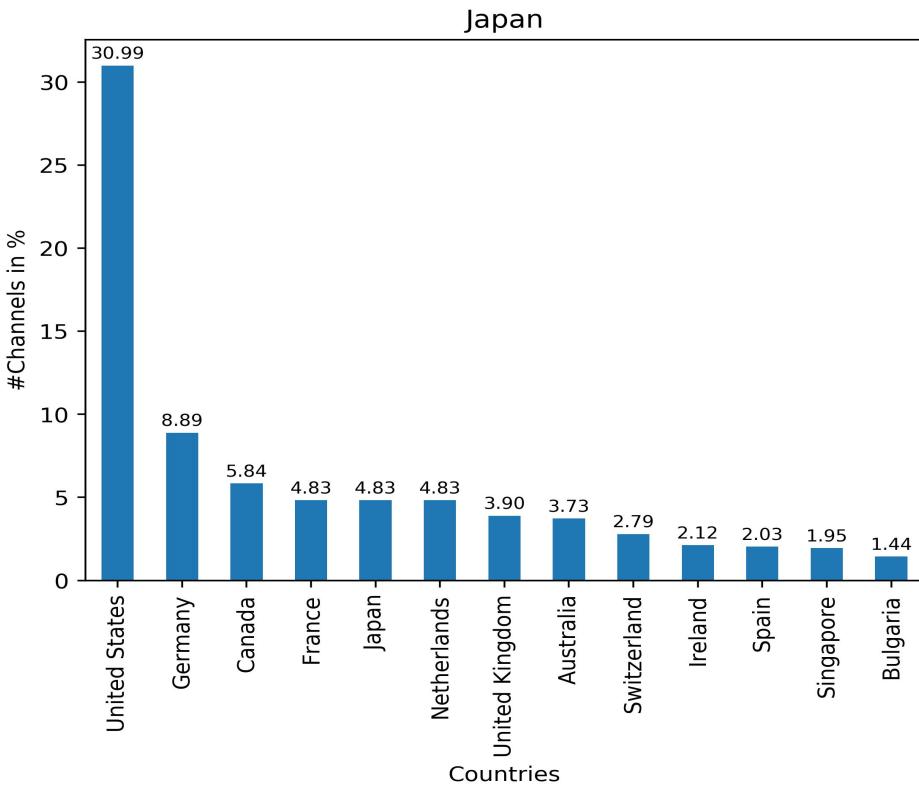
Node Classification - Takeaways

- Nodes can be classified based on default values in the gossip messages
- Collect data over a longer period to improve success, since the user could have changed the values
- Most users stick to the default values
- LND is by far the most popular client
 - Precompiled version
 - Available for Windows from the beginning

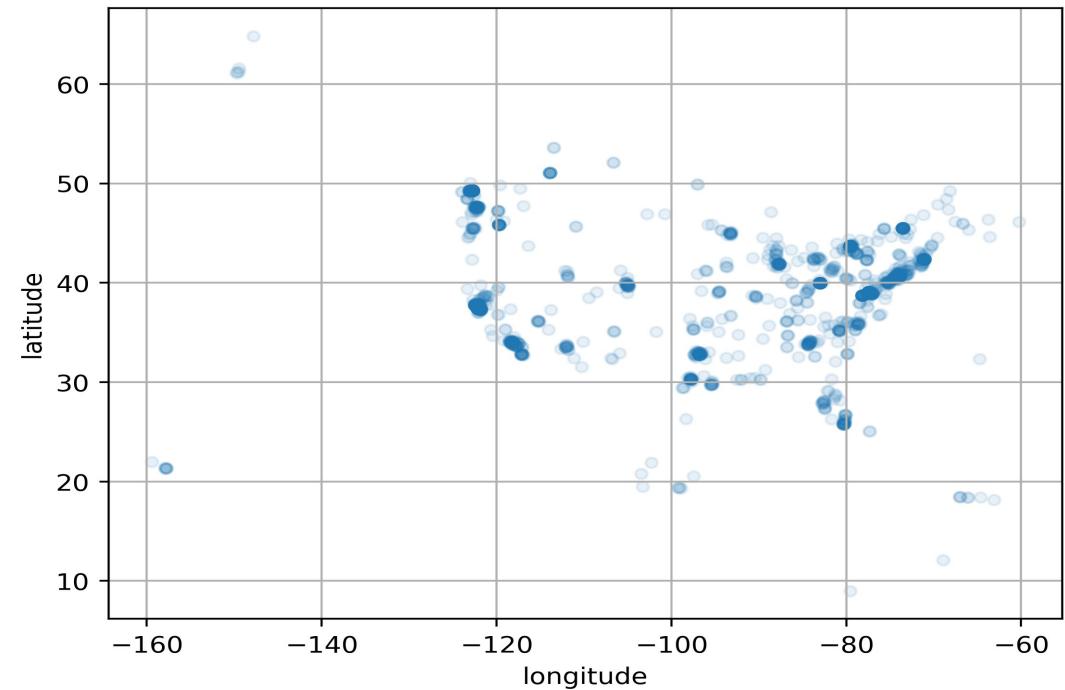
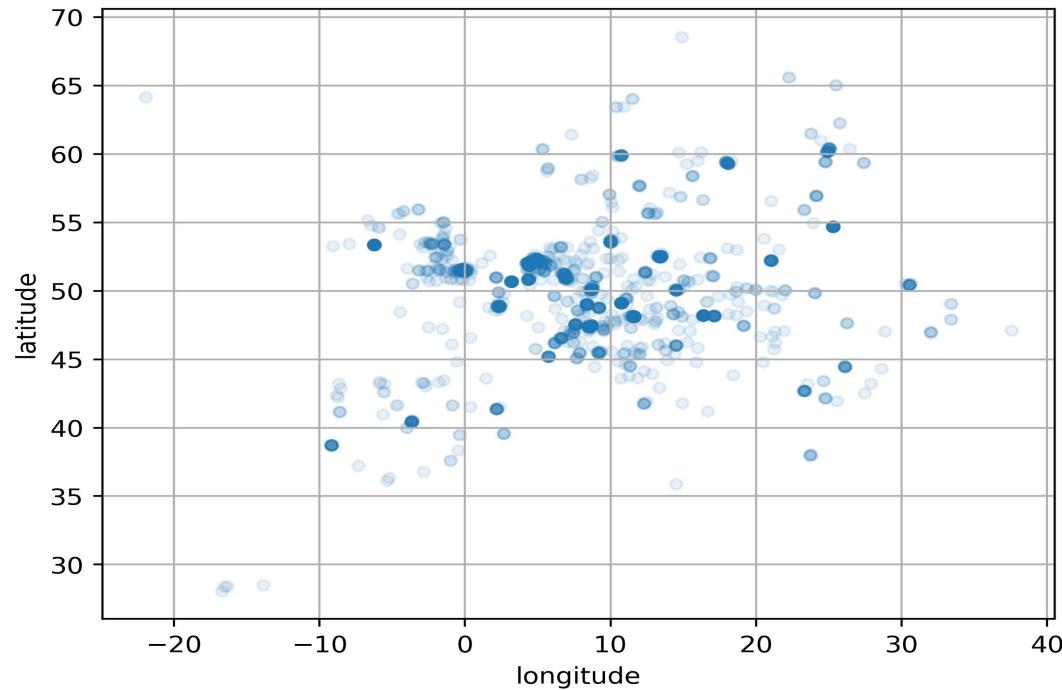
Geographical Analysis – Implementation Distribution



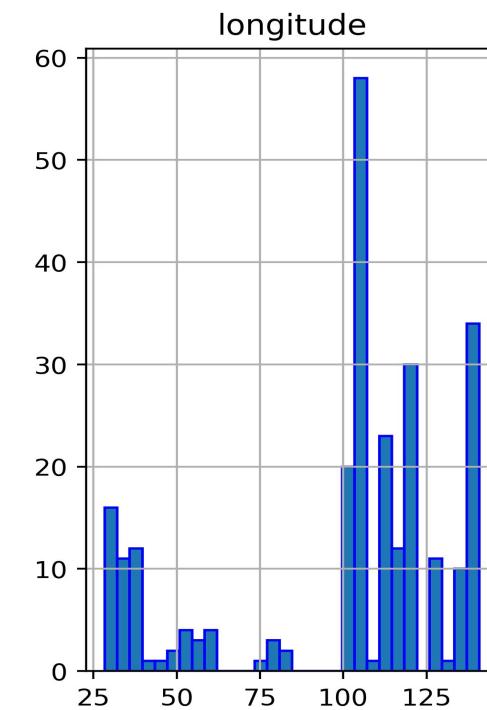
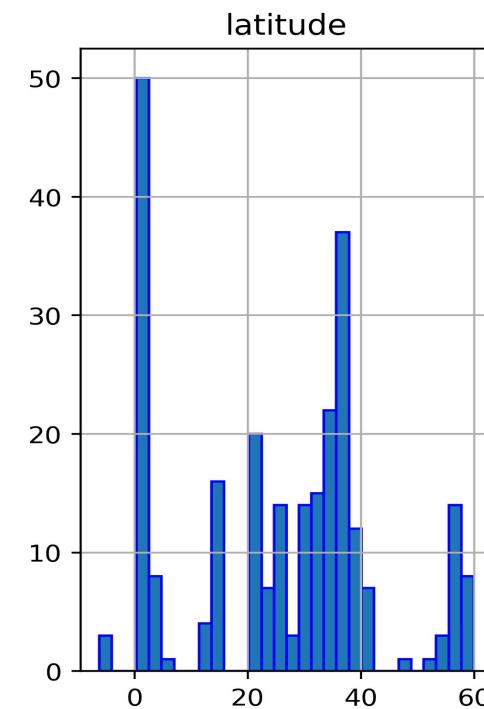
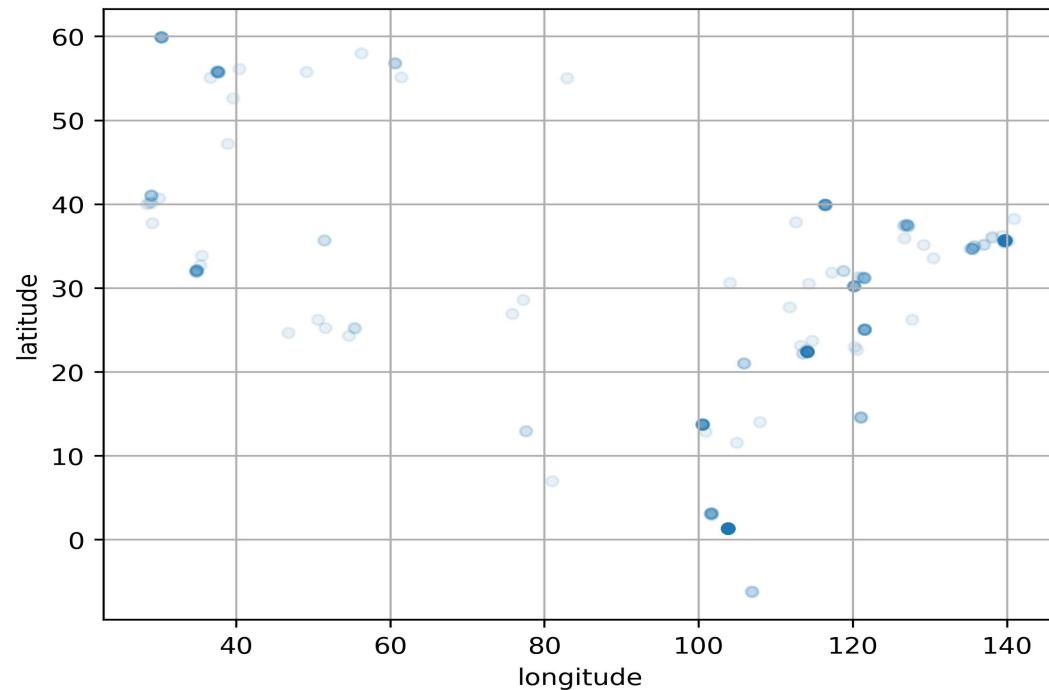
Geographical Analysis – Channel Connections



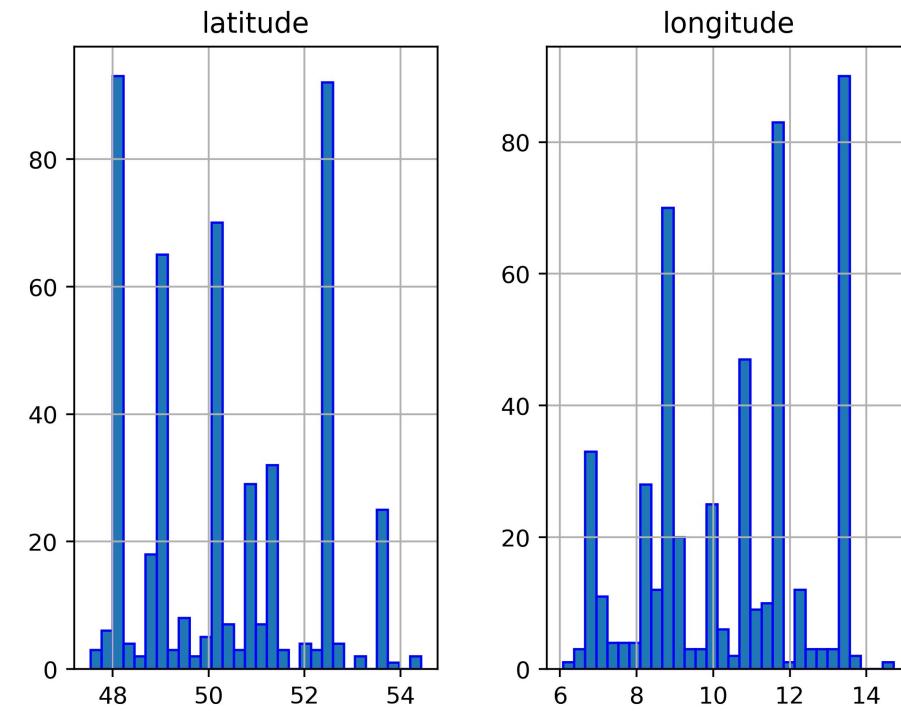
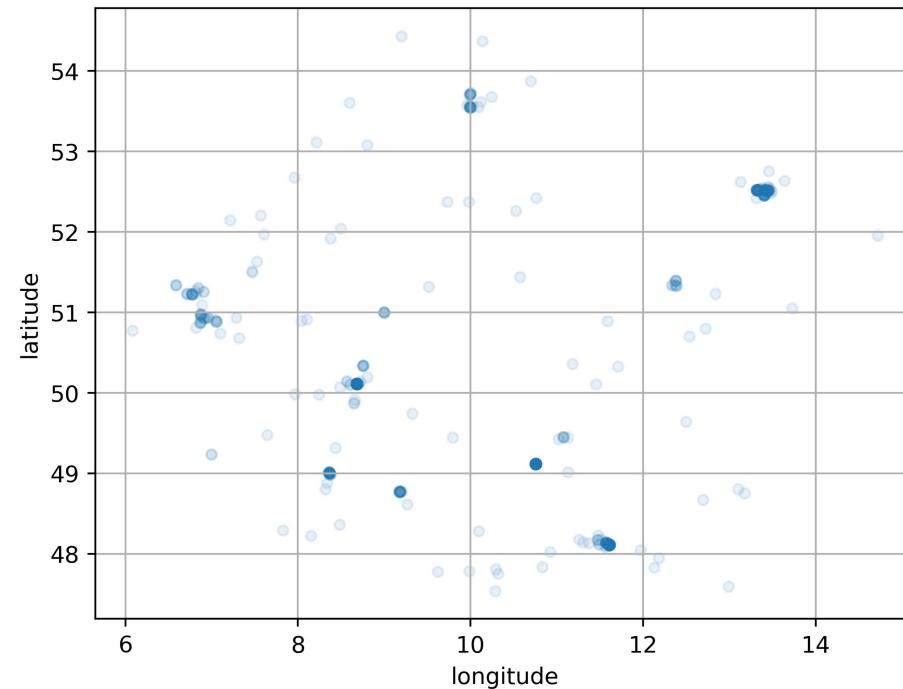
Geographical Analysis – Europe & North America



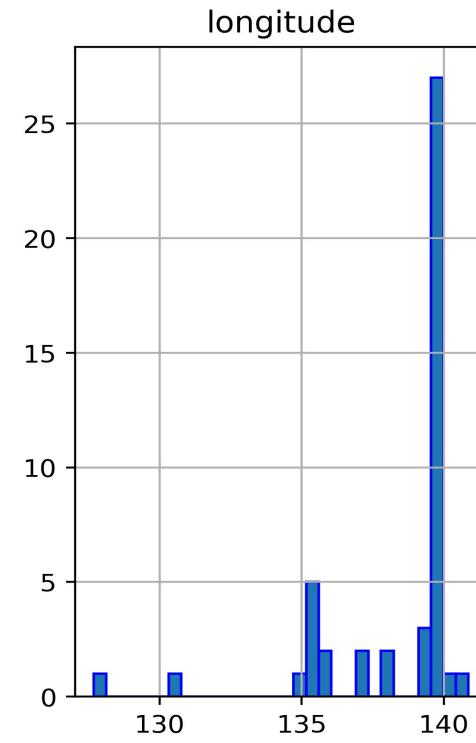
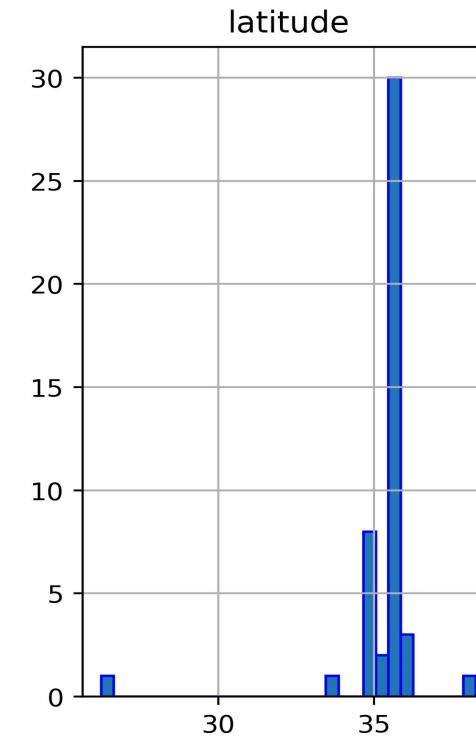
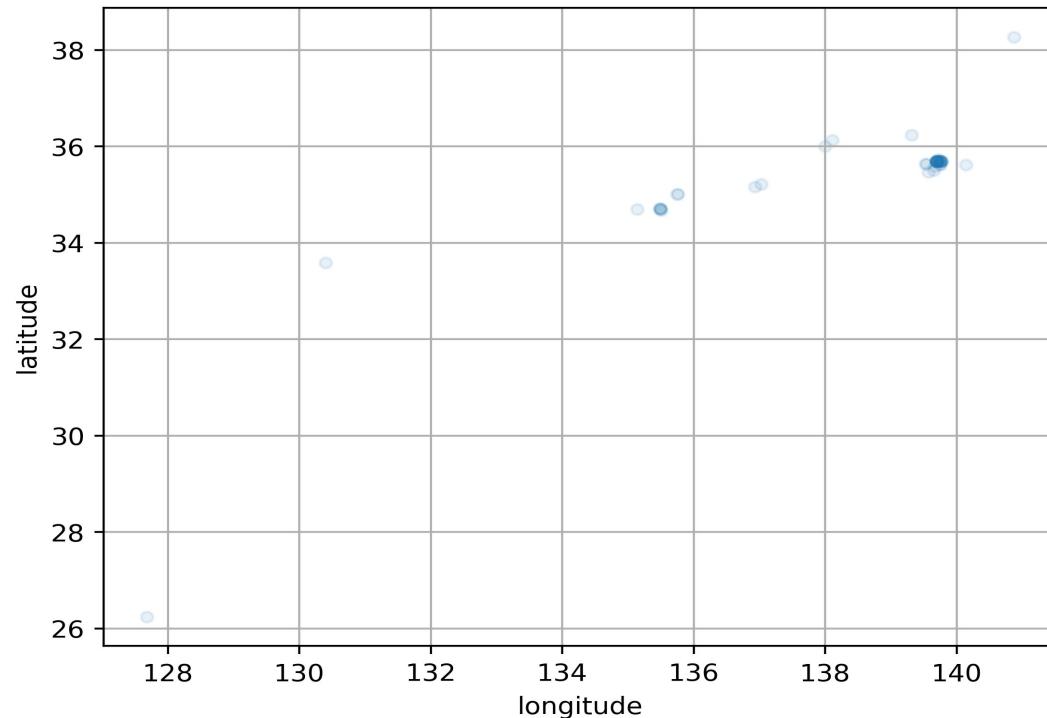
Geographical Analysis - Asia



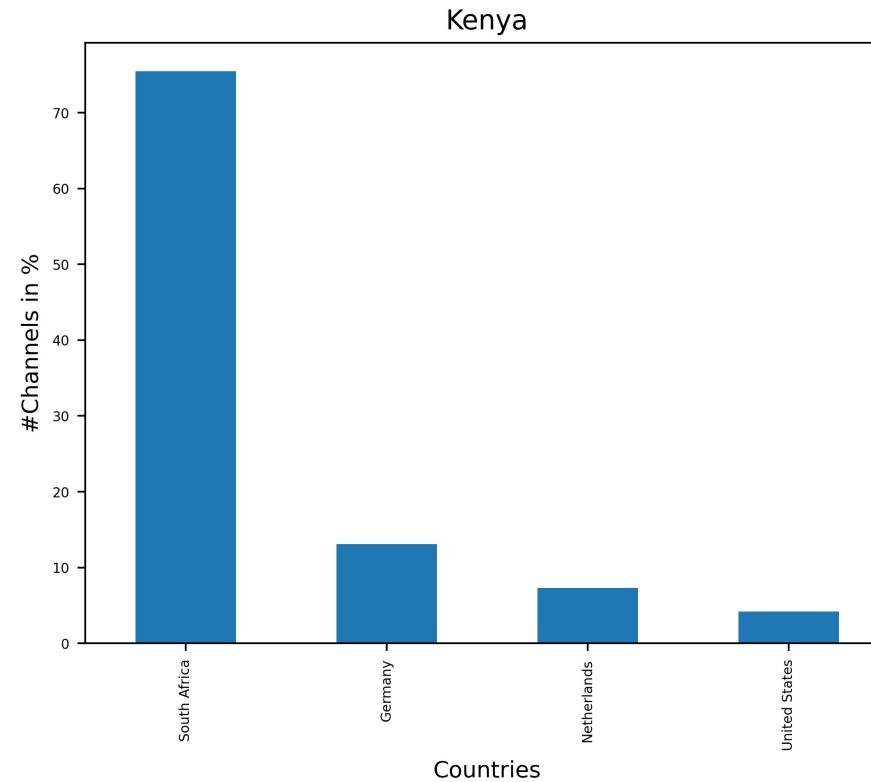
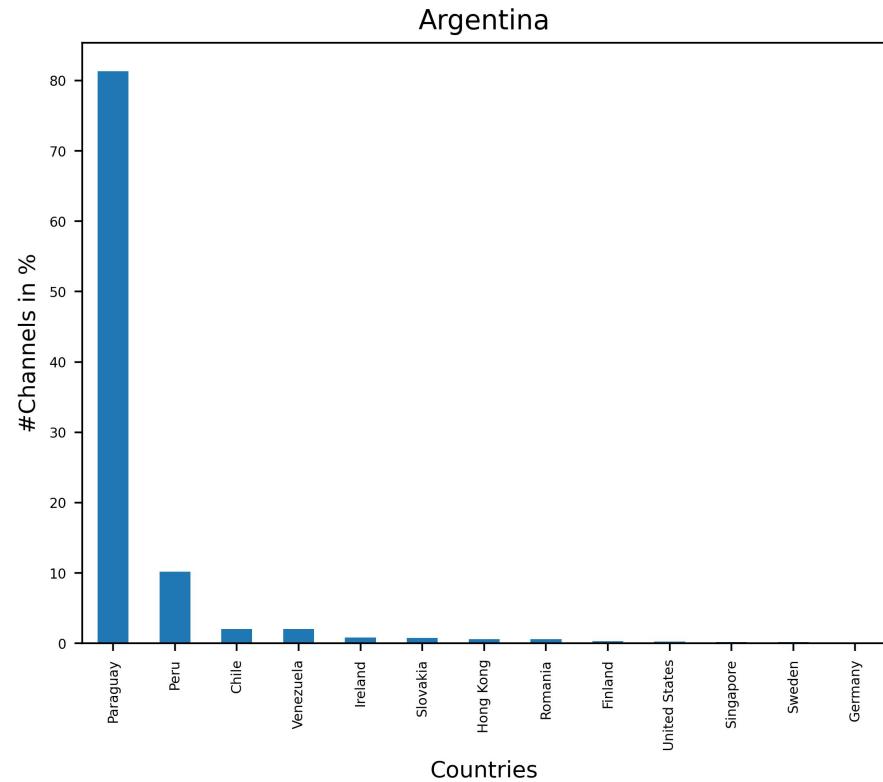
Geographical Analysis – Germany



Geographical Analysis - Japan



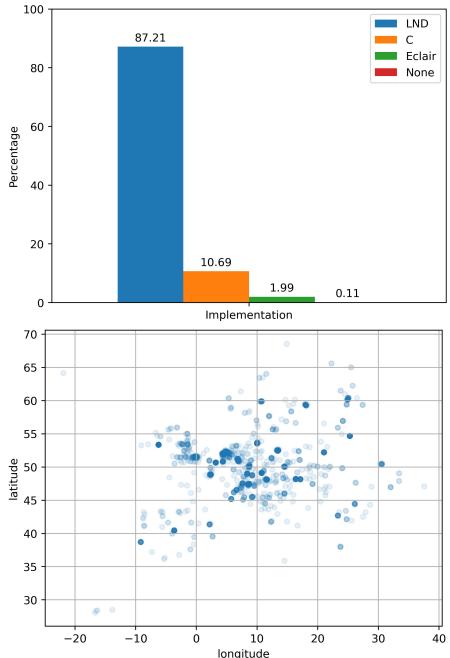
Geographical Analysis – Channel Connections



Geographical Analysis - Takeaways

- LND is predominant in 78 out of 81 observed countries
- Countries where LND is not predominant usually have only a few nodes
- Nodes connect to the same large hubs in the same countries, distance does not play an important role
- We can observe that locations, where the node density is higher, tend to have a better infrastructure overall

Summary



- Nodes in the LN can be classified by using the default values in the gossip messages
 - Users can easily change the values, but most of them stick to the default settings
- Is there any other possibility of classification?
 - Since there are three implementations, measuring differences in network performance could be done
- LND is by far the most used client in almost all 81 observed countries
- Nodes tend to connect to large hubs, no matter the distance
- There is also a high connection within countries
 - Possibly due to larger node providers, whose nodes are interconnected



Template for traditional presentations

Font Calibri, version 1.5, 22 February 2017



Basics 1/3

- This sample presentation contains information about how to use this template. It shows all slide layouts, this template offers. Photos in this file are the work of Joseph Krpelan und Barbara Mair.
- When creating your presentation please follow the guidelines in this sample presentation, which can also be used as a starting point for your presentation. In this case delete all slides/texts and fill in your own content.
- In addition to layouts (details on layouts on page 5), that enable an easy creation of presentations, the template also offers the corporate design colours and fonts .
- Furthermore you will find instructions based on Microsoft Office 2013 (and similar in other Office versions).

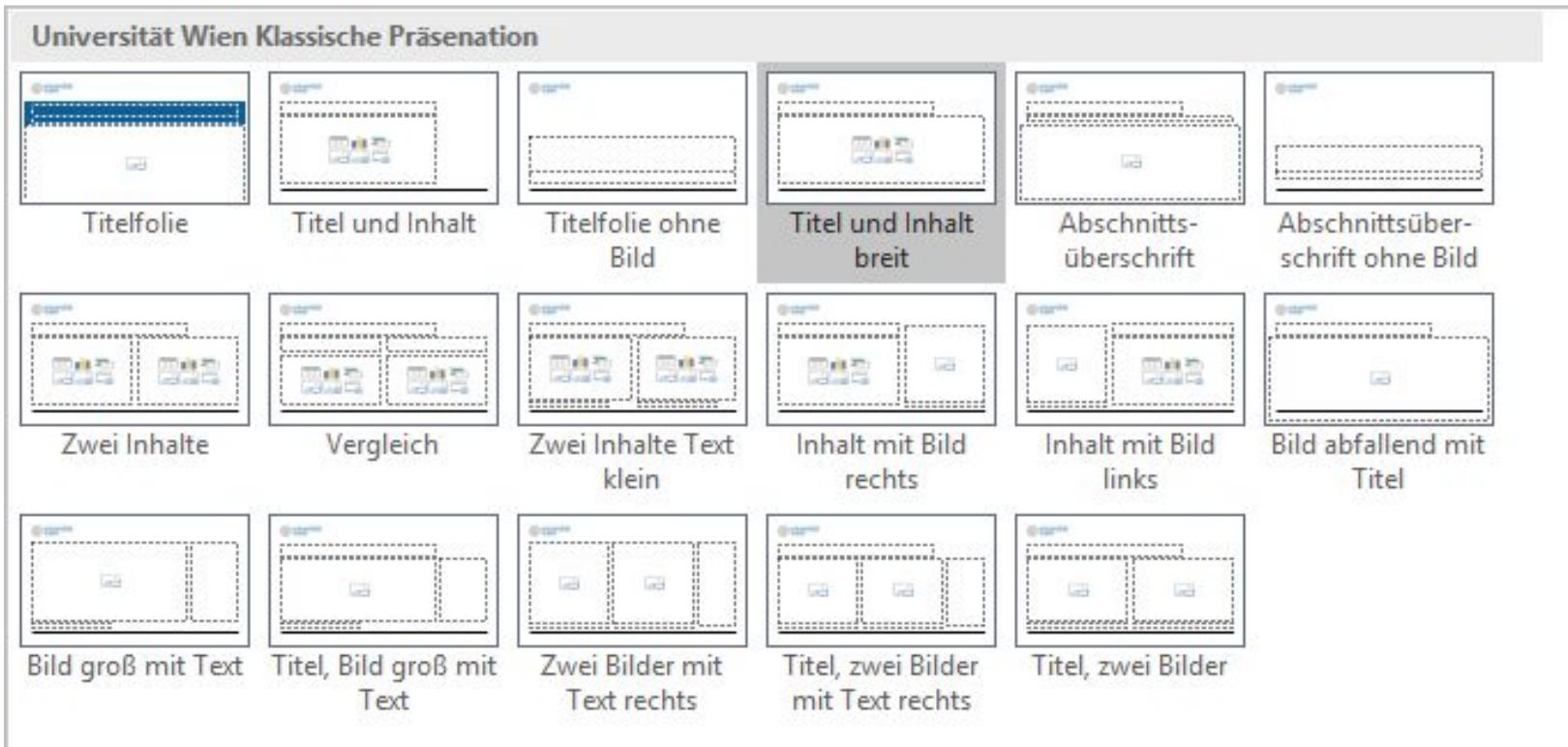
Basics 2/3

- The following types of presentation templates are available (both with font *Source Sans Pro* and *Calibri*)
 - **Template for traditional presentations** (e.g. for image purposes) in format 16:9
 - **Template for teaching and research** in format 4:3
- Please note that the font *Source Sans Pro* is not installed on every computer – in case of doubt (e.g. for conferences) please use the template based on font *Calibri*.

Basics 3/3

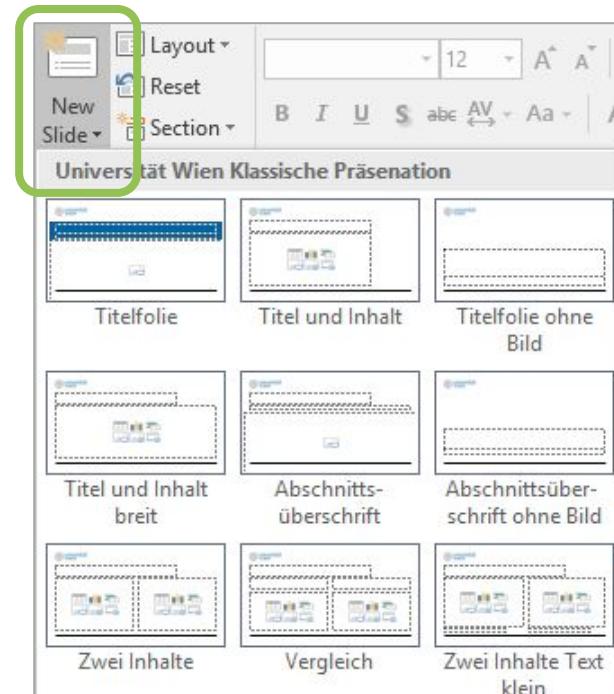
- Please avoid copying and pasting slides between the templates.
By applying the option *Use destination Style* your slides will be adapted to the template, but follow-up processing will be necessary in most cases.
- Furthermore there is a **handout template for teaching and research** available. This template can be used for preparing handouts with PowerPoint, which will not be presented via beamer. The template features a smaller font size for running text.
Please do not use this template for your presentations!

Available slide layouts for traditional presentations



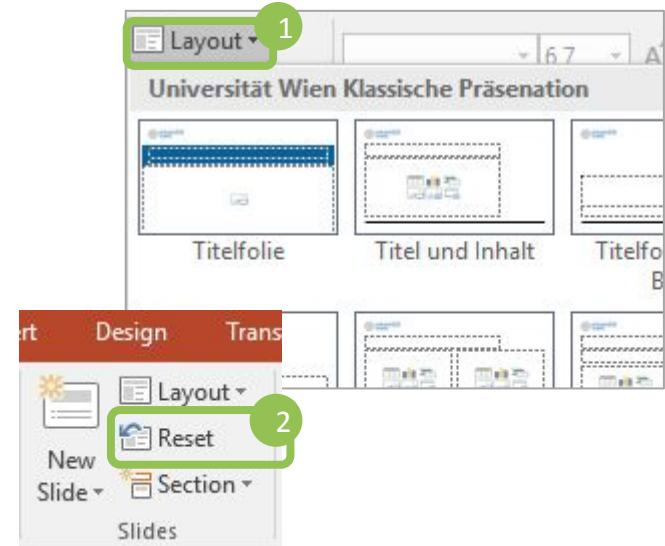
Use of layouts for new slides

- The template offers several **slide layouts**, that will assist you in creating your slides. Please make use of them!
- Please note that for technical reasons, the slide names are in German (but explained in detail in this sample file).
- Choose a layout when creating a new slide:
 - Click on the lower part of the button *New Slide* (ribbon/menu bar > *Home* > *Slides*).
 - Then you will see all available layouts.
 - Select the appropriate layout.



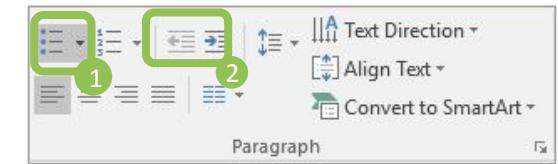
Change slide layouts afterwards

- You can also change a slide layout later:
 - Click on *Layout* (1) (ribbon *Home* > *Slides*) and select the desired layout from the dropdown menu.
- In some cases it might be necessary to reset the layout of your slide by selecting *Reset* (2) (on ribbon *Home* > *Slides*).



Tips for text layout

- Please use the placeholders located on the layouts to enter your text or other elements. Avoid using manually placed text boxes.
- The sample slides (page 21 onwards) contain detailed information on font sizes, which are also pre-set in the placeholders.
- By using *bullets* (1) and *list levels* (2) on ribbon *Home > Paragraph* you have several options to arrange your text.
- Please note: text size does not automatically resize when too much text is entered in a placeholder.



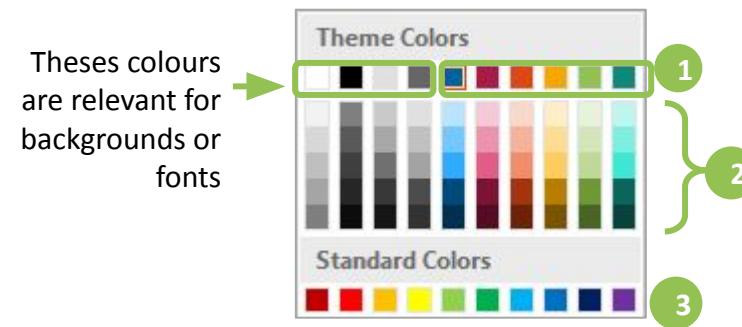
Use of placeholders for pictures, charts, etc.

- The slide layouts contain different types of **placeholders**; some allow the import of different content types (charts, tables, pictures, text), others only the import of pictures. In these placeholders you can easily insert pictures by clicking the placeholder and selecting the desired picture (from pc/file share). The picture will automatically be placed within the placeholder and resized.
- Most layouts also offer **placeholders for reference information**.
Note copyright-guidelines when using pictures!
- The templates also offer **guides/grid-lines** to easily align objects on your slides. By pressing the “ALT”-key you can deactivate the snap-to-grid function (further details [here](#) and [here](#) in Microsoft’s online help).

Colour codes

- The templates offer predefined colours – the **Theme Colours** (see picture on the right (1)).
- These colours will also be automatically applied to elements like shapes, tables or charts.
- For your information you also will find the R/G/B codes for the accent-colours.

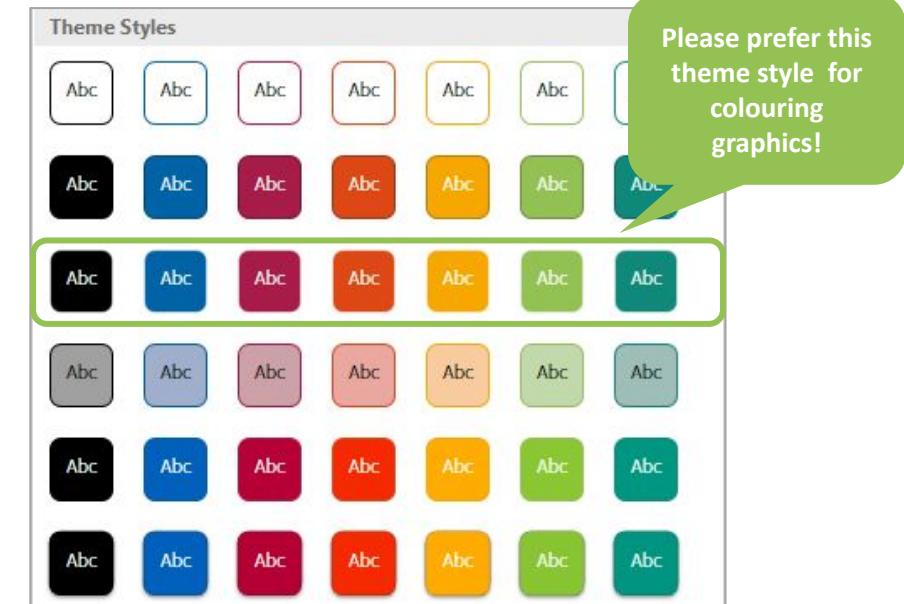
0 99 166	167 28 73	221 72 20	246 168 0	148 193 84	17 137 122
Accent 1	Accent 2	Accent 3	Accent 4	Accent 5	Accent 6



- ➊ **Accent colours:** are automatically applied on charts, tables or SmartArt graphics.
- ➋ **Shades of accent colours:** are automatically generated by PowerPoint and are also used for charts or graphics.
- ➌ **Standard colours:** can be used on demand as well as user-defined colours

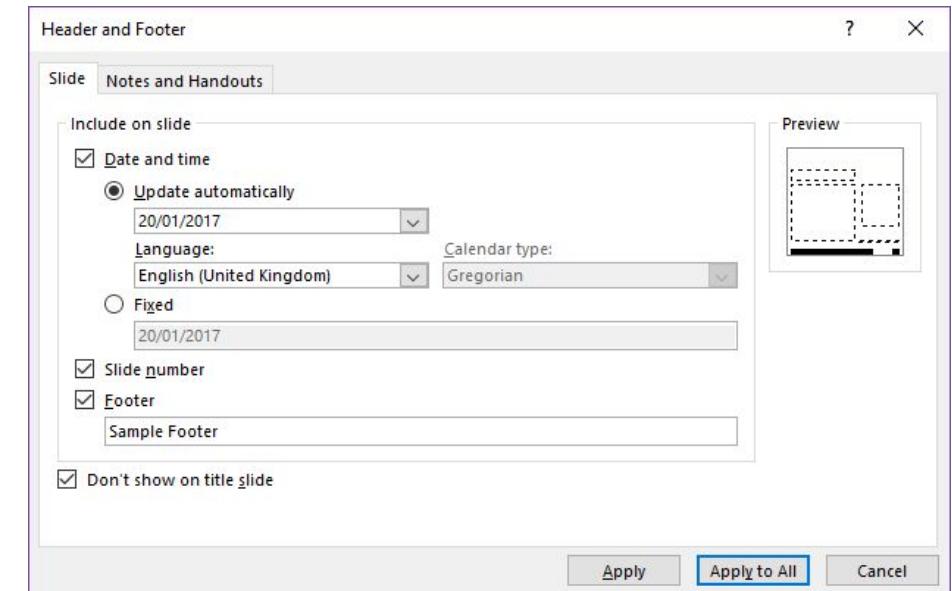
Further use of the accent colours

- The accent colours are also used in **Theme Styles** (e.g. used for colouring shapes). Please apply a uniform style for graphics (clear use of shape and colour).
- Preferably simple styles should be used – especially with complex content.



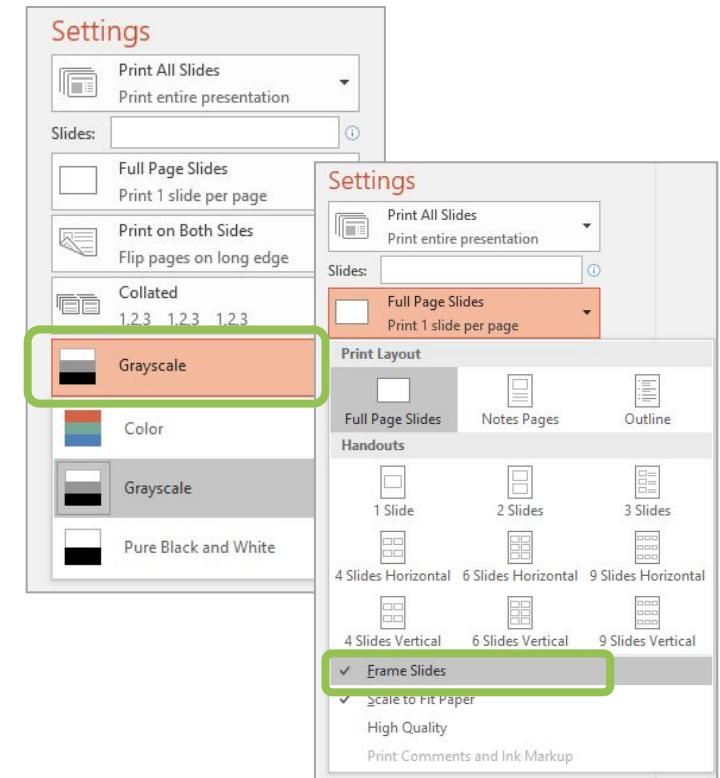
Insert consistent footer information

- Choose *Header & Footer* (in ribbon *Insert > Text*).
- Activate the desired checkboxes and enter a footer text.
- Please make sure the checkbox next to *Don't show on title slide* is activated.
- Confirm by selecting *Apply to all*.
- Please do not change the footer/slide number/date via the slide master – this may cause problems!



Toner- and ink-reduced printing

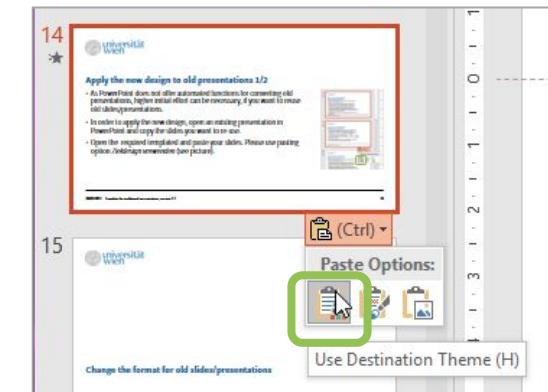
- The optimised PowerPoint templates allow you to save toner and ink when printing.
- Select the desired option in the print dialogue via ribbon *File > Settings*, if you do not need printout in colours:
 - **Greyscale**: graphic elements, charts etc. will be printed in greyscale.
 - **Black**: elements will be printed in black (and grayscale fill in charts will be replaced by patterns)
- Please also select *Frame Slides*, in order to present slides more clearly, especially when several slides are printed per page.



Change the format of old slides/presentations

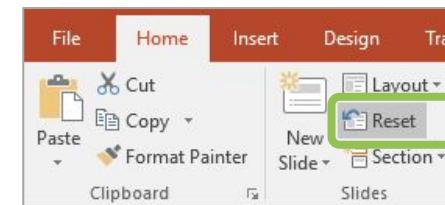
Apply the new design to old presentations 1/2

- As PowerPoint does not offer automated functions for converting old presentations to the new design, higher initial effort might be necessary, if you want to reuse old slides/presentations.
- In order to apply the new design, open an existing presentation in PowerPoint and copy the slides you want to use.
- Open the required template and paste your slides. Please use the pasting option *Use Destination Theme* (see picture).



Apply the new design to old presentations 1/2

- In some cases follow-up processing might be necessary for some slides.
- If your slides do not look as expected, please assign the appropriate slide layout to the relevant slide: select the slides and use *Layout* (in ribbon *Home > Slides*).
- For most slides the layout *Titel und Inhalt* is suitable.
- In order to delete manual formatting, choose *Reset* (ribbon *Home > Slides*).



Tips for troubleshooting

- If your old presentations were not based on placeholders or the layouts were very different, text will not automatically be placed in the place-holders. In this case you have to copy and paste the text manually and reset your slides afterwards.
- Furthermore it may happen (depending on the previously used template), that graphics (old logos, lines, etc.) still appear on your slides. If it is not possible to delete these elements within the slides, please go to *Slide Master View* (*Ribbon View > Master Views*) and try to delete the wrong elements there.

Adjustment of different footers 1/3

- If you use slides from different presentations (with different footers), these elements are not adjusted automatically (this may be the case with older versions of PowerPoint).
- In order to unify these elements:
 - Go to a slide that contains the **correct** footer elements
 - Choose Headers & footers (in ribbon *Insert > Text*) and select *Apply to all*.
 - In many cases this solves the problem.

Adjustment of different footers 2/3

- If this does not work, try the following steps:
 - Reset layout for slides with wrong footers (ribbon *Home* > *Slides*).
 - Go back to a slide that contains the **correct** footers.
 - Choose *Headers & Footers* (in ribbon *Insert* > *Text*) and deselect all checkboxes.
 - Then select *Apply to all*.

Adjustment of different footers 3/3

- Please stay on a slide where the footer was correct before and re-open the *Headers & Footers* dialog again (in ribbon *Insert > Text*).
- Now select all required checkboxes for date, slide number and footer, check the footer text and confirm by *Apply to all*.
- Now all footers should be fixed.
- Further information: [Change or delete header and footer information in a presentation](#)

Sample layouts

Layout “Titelfolie mit Bild” – single-line – 36pt

Subtitle – 18 pt



Picture size
11.5 x 33.9 cm

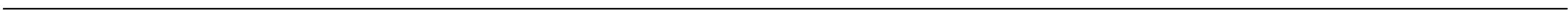
Layout “Titel und Inhalt” = default layout

Title – 28 pt

- Running text 22 pt, layout offers a content placeholder.
- Sample text: Far far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.
- A small river named Duden flows by their place and supplies it with the necessary regelialia. It is a paradisematic country, in which roasted parts of sentences fly into your mouth.
- One day however a small line of blind text by the name of Lorem Ipsum decided to leave for the far World of Grammar.

Layout “Titelfolie ohne Bild” – 36 pt

Subtitle, also two lines ... – 18 pt



Layout “Titel und Inhalt breit” for lots of text with header (also two lines)

- Running text 22 pt, layout offers a larger content placeholder.
- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.
- A small river named Duden flows by their place and supplies it with the necessary regelialia. It is a paradigmatic country, in which roasted parts of sentences fly into your mouth.
- One day however a small line of blind text by the name of Lorem Ipsum decided to leave for the far World of Grammar. The Big Oxmox advised her not to do so, because there were thousands of bad Commas, wild Question Marks and devious Semikoli, but the Little Blind Text didn't listen.

Layout “Abschnittsüberschrift” – 28 pt

Subtitle – 16 pt



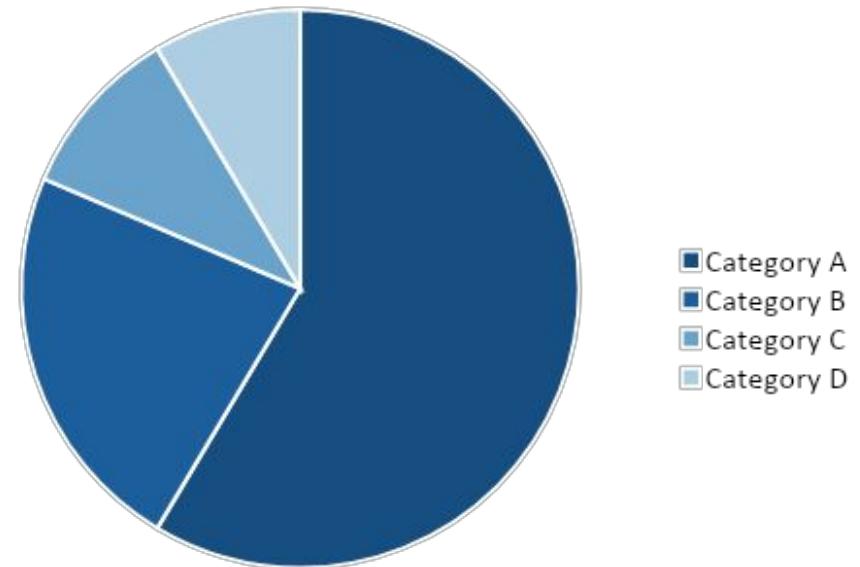
Layout “Abschnittsüberschrift ohne Bild” – Title also possible in two lines – 28 pt

Subtitle – 16 pt

Layout “Zwei Inhalte”

- This layout offers two content placeholders.
- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts.
- A small river named Duden flows by their place and supplies it with the necessary regelialia. It is a paradisematic country, in which roasted parts of sentences fly into your mouth.

Sample Title



Layout “Vergleich”

Advantages (or other title)

- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts.
- Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.

Disadvantages (or other title)

- Sample text: A small river named Duden flows by their place and supplies it with the necessary regelialia.
- It is a paradisematic country, in which roasted parts of sentences fly into your mouth.
- One day however a small line of blind text by the name of Lorem Ipsum decided to leave for the far World of Grammar.

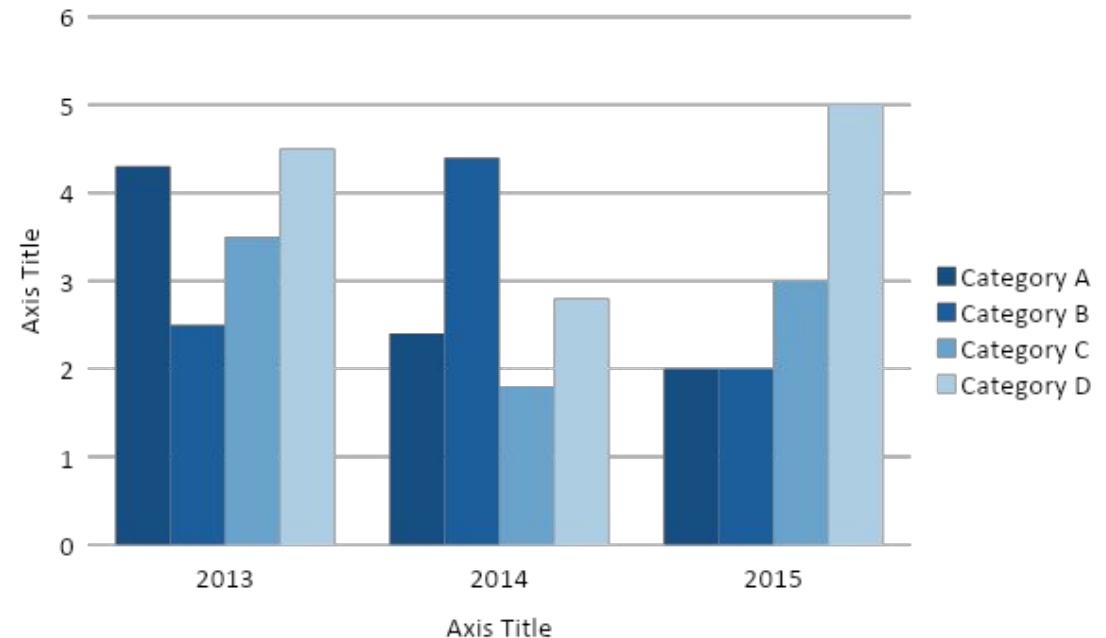
Layout “Zwei Inhalte Text klein”

Running text 18 pt

Two content placeholder with smaller font size.

- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.
- A small river named Duden flows by their place and supplies it with the necessary regelialia. It is a paradisematic country, in which roasted parts of sentences fly into your mouth.

Reference, source or copyright information in 12 pt



Reference, source or copyright information in 12 pt

Layout “Inhalt mit Bild rechts”

- Content placeholder on the left, picture placeholder on the right.
- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.
- A small river named Duden flows by their place and supplies it with the necessary regelialia.



Reference, source or copyright information



Reference, source or copyright information

Layout “Inhalt mit Bild links”

- Picture placeholder on the left, content placeholder on the right.
- Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.
- A small river named Duden flows by their place and supplies it with the necessary regelialia. It is a paradisematic country, in which roasted parts of sentences fly into your mouth.



Layout “Bild abfallend mit Titel”

Picture size
12.7 x 33.9 cm





Reference, source or copyright information

Layout “Bild groß mit Text”
Running text 16 pt
Larger picture placeholder on the left, text placeholder on the right

Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts.

Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.

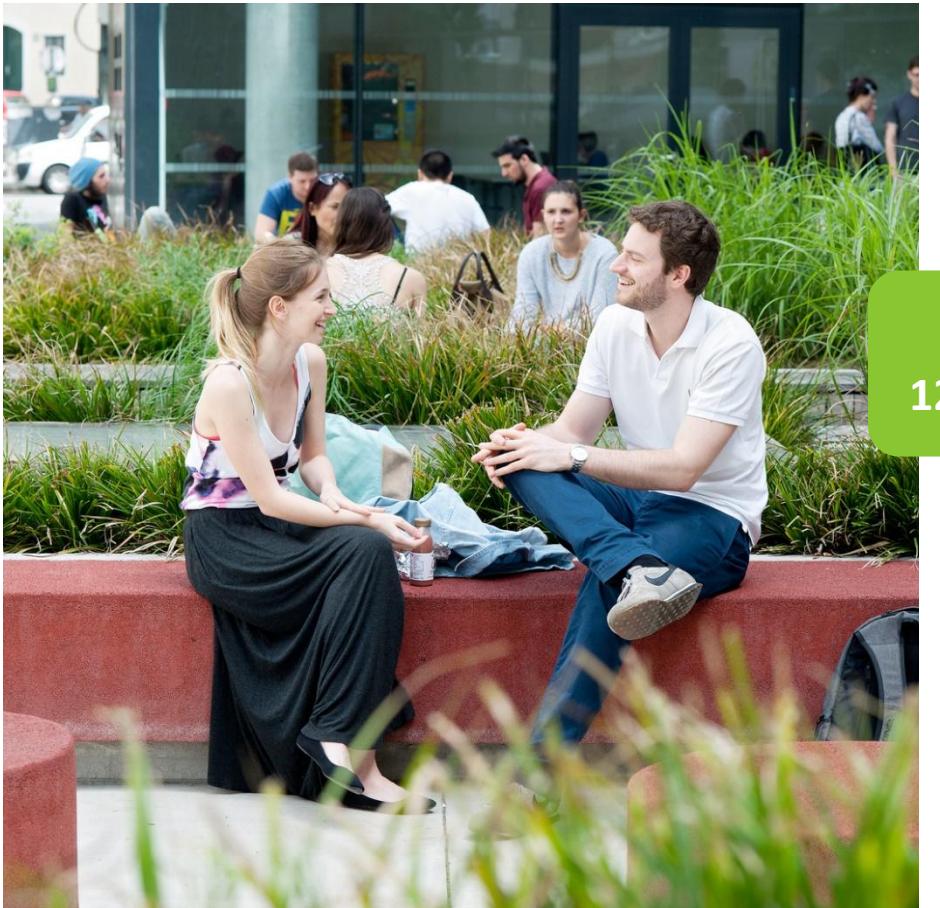
Layout “Titel, Bild groß mit Text”



**Running text 16 pt
Header, larger picture
placeholder on the left, text
placeholder on the right**

Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.

Reference, source or copyright information



Reference, source or copyright information



Reference, source or copyright information

Picture size
12 x 12.1 cm each

Layout “Zwei Bilder mit Text rechts” – running text 16 pt

Two picture placeholders and text place-holder on the right

Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts. Separated they live in Bookmarksgrove right at the coast of the Semantics, a large language ocean.

Layout “Titel, zwei Bilder mit Text rechts”



Reference, source or copyright information



Reference, source or copyright information

Picture size
9.5 x 12.1 cm each

Running text 16 pt
Title, two picture placeholders and text placeholder on the right

Sample text: Far away, behind the word mountains, far from the countries Vokalia and Consonantia, there live the blind texts.

Layout “Titel, zwei Bilder”



Reference, source or copyright information



Reference, source or copyright information